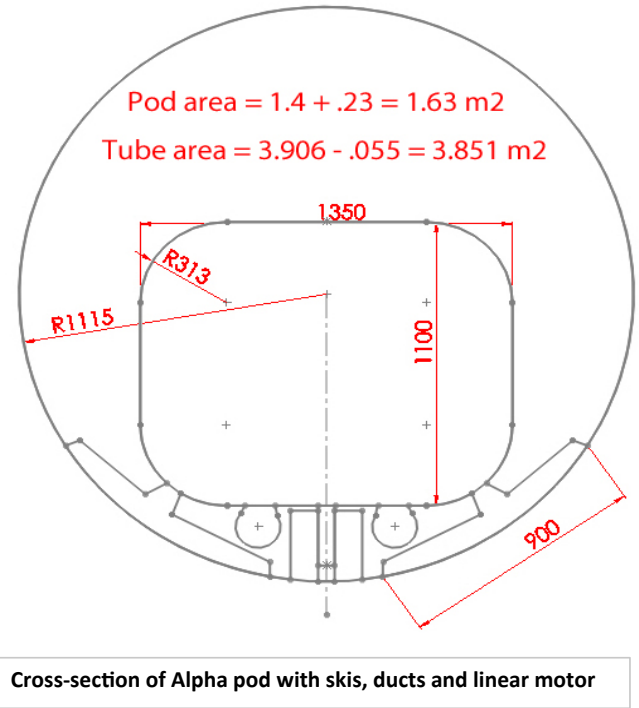**This spreadsheet is looking at the nominal Mach No of the flow over the pod at speed. The pod will displace gas which needs to flow back over trhe pod.**

The flow may exceed Mach 1 which is not possible due to Kantrowitz. The solutions are compressing the gas, either by an internal compressor or thrust on the pod.

	Alpha original, air	Alpha, steam and bigger tube	Cheetah with wheels and steam	
Tube diameter m	**2.230**	**2.700**	**2.500**	
Rounded rectangle pod section				
Pod width m	1.350	1.350		
Pod height m	1.100	1.100		
Rounded rectangle radius m	0.314	0.314		
Area loss due round corners	0.085	0.085		
Pod hull area, rectangular	1.400	1.400		
Round pod section				
Pod diameter m			1.700	Cheetah pod is 1.6 m ID
Pod area m2			2.270	
Pod basic frontal area used	1.400	1.400	2.270	
Skis, duct, linear area m2	0.230	0.230	-	Cheetah is a clean cylinder with no extra frontal area
Pod tot frontal area m2	**1.630**	**1.630**	**2.270**	the wheels are on the reduced area of the nose and tail cone.
Tube basic area m2	3.906	5.726	4.909	
Area linear motor m2	0.055	0.055	-	
Tube tot area m2	3.851	5.671	4.909	
Tube/Pod area ratio %	42.3	28.7	46.2	
Annulus area between tube and pod m2	2.221	4.041	2.639	
Tube pressure Pa	100	160.77	160.77	The pressure for the steam has been increased
Tube temp K	292	292	292	to give the same density and mass flow as air
Gas Constant R	8314	8314	8314	Tube pressure has no affect on Kantrowitz
Gas Mol Wt (Air 28.97, steam 18.02)	28.97	18.02	18.02	
Heat cap ratio (Air 1.4 steam 1.33) K	1.40	1.33	1.33	
Gas density Kg/m3	0.00119	0.00119	0.00119	Density = Mol * Press / (R * Temp)
Speed of sound m/s	342.52	423.30	423.30	Speed of sound = sqrt(K * R/Mol * Temp)
Capsule speed km/h	1220	1220	1220	
Capsule speed M/s	338.9	338.9	338.9	
Gas displaced by pod m3/s	552.5	552.5	769.3	Gas displaced is pod fontal area times velocity
Compressor inlet, ski and nozzle Kg/s	0.490	0.490	From Alpha	
Compressor inlet m3/s	410.6	410.6	Vol = Mass * Density	
Compressor diameter estimate m	1.200	1.200	Note that the diameter of the compressor inlet needs to be very large	

Pod area = 1.4 + .23 = 1.63 m2

Tube area = 3.906 - .055 = 3.851 m2

1350
R313
R1115
1100
900

Cross-section of Alpha pod with skis, ducts and linear motor

Velocity compressor inlet m/s	363.0	363.0	
Mach No compressor inlet	1.06	0.86	Inlet velocity must be less than Mach 1

This section looks at the flow at the front of the pod, where most of the air displaced by the pod is accelerated back over the pod.
For Alpha, the volume of the backflow is reduced by the volume of air pumped thru the compressor.

Vol backflow at pod front m3/s	141.91	141.91	769.31
Backflow velocity rel tube m/s	63.90	35.12	291.48
Backflow velocity vs pod m/s	403	374	630
Pod Mach No at front	1.18	0.88	1.49

At the back of the pod, the gas pumped to the skis has all escaped into the tube. So we only count the duct gas as reducing the flow over the pod.

Comp inlet flow for nozzle only Kg/s	0.290	0.290		
Inlet flow vol flow,nozzle only m/s	243.0	243.0		If the nominal velocity over the pod exceeds Mach 1, there is a problem which needs to be solved
Vol backflow over pod at back m3/s	309.5	309.5		All Kantrowitz solutions need to compress the gas to get the required mass flow.
Backflow vel vs tube	139.4	76.6		Alpha compresses the gas thru a small duct to the back.
Flow velocity vs pod	478.3	415.5		Cheetah has no compressor, but uses the thrust of the wheels
Pod Mach No at back	1.40	0.98	1.49	which increases the density of the gas in the tube, to get the required mass flow